



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460**

October 16, 2000

**OFFICE OF
THE ADMINISTRATOR
SCIENCE ADVISORY BOARD**

Note to the Reader:

The attached draft Subcommittee commentary is undergoing internal Science Advisory Board review (SAB). The commentary has been approved by the authoring Subcommittee and the Environmental Engineering Committee. The draft commentary must also be approved by the Executive Committee before it can be transmitted to the EPA Administrator. The final commentary will be available on request.

This draft has been released for general information. The reader should remember that this is an unapproved working draft and that the document should not be used to represent official EPA or SAB views or advice. Draft documents at this stage of the process often undergo significant revisions before the final version is approved and published.

The SAB is not soliciting comments on the advice contained herein. However, the SAB will accept comments on the issues listed below. The SAB is not obligated to address any responses which it receives.

1. Are any statements or responses made in the draft unclear?
2. Are there any factual errors?

For further information or to respond to the questions above, please contact:

Kathleen Conway, Designated Federal Officer
Science Advisory Board (1400A)
US Environmental Protection Agency
Washington, DC 20460
(202) 564-4559 Fax: (202) 501-0582
E-Mail: conway.kathleen@epa.gov

G:\SAB\REPORTS\2001report\2001drafts\EEC2001\Measures\October16.wpd

EPA-SAB-EEC-COM-00-XXX

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street SW
Washington, DC 20460

Subject: Measures of Environmental Technology Performance

Dear Ms. Browner:

At its November 1997 retreat, the Science Advisory Board's Executive Committee encouraged the standing committees to undertake more self-initiated efforts. This commentary is one of several Environmental Engineering Committee initiatives undertaken in response to that guidance.

Briefly, the Committee recommends in this letter that the Agency build on existing strengths in technology evaluation and quality management to provide easy access to reliable information about a wider suite of measures of environmental technology performance. It does so because access to such information is increasingly important for evaluating the effectiveness of risk reduction programs and projects.

Three trends cause the Committee to call your attention to the need for an expanded suite of measures of environmental technology performance. These are:

- a) the expanding use of non-regulatory approaches to environmental protection,
- b) the increasing demand from the international community for effective environmental technology, and

1 c) the growing desire for sustainable environments.

2 Because of these trends, decision-makers will require ready access to a broader suite of
3 information on environmental technology performance than is currently available. On
4 account of its demonstrated strengths in technology evaluation and quality management,
5 EPA has the opportunity to contribute to such information-based decision-making by
6 collecting and disseminating additional information on environmental technology
7 performance.

8 The need to broaden criteria for evaluating environmental technology performance
9 and widely disseminating relevant information has been recognized by other organizations.
10 For example, the United Nation's Environment Program's recent conference on
11 sustainability and verification stressed the importance of making the right risk reduction
12 decision the first time – especially in impoverished countries. Public and private decision-
13 makers in the U.S. and abroad use evaluations of environmental technology performance
14 to determine whether a given technology can potentially address a given problem. If
15 information on relevant measures of technology performance is not available to decision-
16 makers, sub-optimum decisions could be made in technology selection: and sub-optimum
17 decisions may result in increased risks to human health and the environment.

18 The more reliable evaluations tend to be government sponsored and the EPA is the
19 major, although not sole, provider of such evaluations. EPA evaluates the performance of
20 environmental technologies and reports the results to decision-makers and, within the
21 limits the Agency has established, it does so with skill and credibility. Already a world
22 leader in applying the concepts and practices of quality assurance to data collection and
23 analysis, EPA has pioneered the extension of these concepts to evaluating technology
24 performance. Because of the trends mentioned above and the resulting opportunities for
25 environmental protection, the Committee now recommends that the Agency develop a
26 more comprehensive suite of measures for evaluating environmental technology

performance. These measures can be used by the Agency and others to develop the necessary information for decision-makers charged with selecting technologies for use.

In preparing this commentary, the Committee has used the expertise of individual members and consultants; experience gained since 1995 in four reviews relating to environmental technology evaluation; reviews of the Agency's quality management system and its implementation; the participation of two members in the November 1999 EPA-sponsored Industrial Ecology Workshop; the March 2000 review of the Environmental Technology Verification Program; and interactions with EPA staff and managers of other relevant national programs. The attachment provides the background, supporting details, and related recommendations.

We look forward to a written response to the Committee's recommendations to make environmental technology performance measures more comprehensive and useful. Please contact us if we may be of further assistance.

Sincerely,

Dr. Morton Lippmann, Interim Chair
Executive Committee
Science Advisory Board

Dr. Hilary Inyang, Chair
Environmental Engineering Committee
Science Advisory Board

Dr. Edgar Berkey, Chair
Subcommittee on Measures of Technology Performance
Environmental Engineering Committee

ATTACHMENT: Measures of Environmental Technology Performance

Measures of Environmental Technology Performance

1. Existing EPA Programs and Policies

EPA evaluates technologies -- Since its formation, the EPA has evaluated and reported on the performance of environmental technologies. Most Agency evaluations are conducted to meet a specific regulatory need. Additionally, two specialized programs exist to conduct formal and independent evaluations – the Superfund Innovative Technology Evaluation (SITE) Program and the Environmental Technology Verification (ETV) Program.

Because the Agency is likely to continue to evaluate environmental technologies, it will be advantageous for the Agency to consider how its evaluation program can be changed to better serve the needs of decision makers. To make technology selection decisions, decision-makers will need answers to questions such as these:

- a) Are measures of environmental technology performance being adequately addressed and integrated into the Agency's role?
- b) Are site, environmental and operating conditions being considered in testing protocols?
- c) Are procedures in place for assuring that performance measures are realistic and adequate for decision-makers?
- d) Do descriptions of performance in final Agency reports convey all the essential measures and pertinent information?
- e) What are the installation, operation and maintenance life cycle costs.
- f) And how can the desired information be obtained cost effectively?

EPA has important and useful policies on quality. - Providing environmental technology performance data of known and usable quality is a significant challenge,

1 especially because the environmental technologies of concern to EPA vary significantly in
2 size, complexity, intended use, and the media in which they operate. The technologies
3 range from relatively simple monitoring or sensing instruments to more complex treatment
4 systems for wastewater, solid and hazardous waste, and air pollution control.

5 Although EPA is a world leader in applying the concepts and practices of quality
6 assurance to obtaining and using environmental data, the application of quality assurance
7 principles and practices to the evaluation of environmental technology performance is a
8 recent development which the Agency needs to fully implement. This is likely to improve
9 technology selection efforts and enhance the transparency of decisions to stakeholders.
10 Also, it is necessary to include measures of performance that realistically indicate to
11 decision-makers how a technology is likely to perform in real-life situations.

12 If, as the Committee believes, future decision-makers will typically demand a more
13 comprehensive suite of measures, then technology evaluators would have to consider
14 appropriate ways to determine technology performance within the expanded. In such
15 instances, EPA policy encourages use of a structured planning process such as the Data
16 Quality Objective process for evaluating environmental technology performance.

17 Application of a systematic planning process, such as the Agency's Data Quality
18 Objectives process, can ensure that:

- 19
- 20 a) measurements are appropriate for achieving project objectives,
- 21 b) data quality is known, and
- 22 c) data are defensible and reproducible.

The systematic planning process would establish clear goals for the evaluations. If the Agency required that all evaluation reports incorporate additional measures of performance, then decision-makers would have a better basis for judging how a technology will perform outside the range of conditions tested; extrapolations of results from one set of circumstances and scenarios to others could then be possible. This is of high utility because resource constraints usually make it impossible to test technologies under the complete set of factorial experiments when they are considered for use beyond the initial set of conditions in which they were tested.

2. The Need for a Wider Suite of Measures

Evaluations that provide maximum value to the decision-makers describe the quality of the performance data being measured, including the bias and variability of the data under varying operating conditions and situations. The Agency could require that technology evaluations include sufficient measures of performance to provide decision-makers with information on how a technology will perform under realistic and likely conditions of use.

If the quality of the performance data is not fully addressed, if test conditions are too tightly prescribed, or if performance under varying conditions is not determined, then the resulting evaluations of technology performance have limited value as decision aids, especially when conditions for proposed use of a technology are somewhat different from those under which tests were performed. Thus, providing adequate information to decision-makers requires that measures of performance used to describe how a technology performs are sufficiently comprehensive.

A useful performance description would include both the experimental uncertainties (which are a part of all technical measurements) and parameters or variables that help describe real-life use of a technology. A successful suite of measures will meet the following criteria:

- a) The measures are based on a variety of realistic and well documented circumstances under which a technology is to be used – or the limited circumstances of testing are clearly documented and emphasized
- b) The measures identify all key variables that affect the performance of a technology.
- c) The measures provide an indication of how rugged a technology is with respect to these variables.
- d) The measures include purchase, installation, operation and maintenance costs
- e) The measures convey in practical terms the level of performance that a technology can meet.

3. Stakeholder Involvement in Determining Performance Measures

Strong stakeholder involvement in the development of verification protocols and test plans, a key aspect of the DQO planning process, has been a strength of the ETV Program. Stakeholder involvement could improve other evaluations by helping determine the most relevant performance measures for decision-making. To determine better measures of environmental technology performance, it would be useful to include stakeholders such as:

- a) regulators,
- b) regulated communities,
- c) technology users,
- d) technology developers,
- e) professional and trade associations,
- f) environmental groups,

- g) financial investment groups, and
- h) insurance underwriters.

Each of these groups is concerned with deciding whether environmental technologies can satisfy given requirements. They are in an excellent position to help the Agency define what information is really needed.

4. Doing More with What We Have

In its 1996 review of the SITE program, the EEC noted that, while there were several cases where competent analyses of several individual technologies in a single technology family, there were no cross-cutting analyses comparing them to one another and drawing general conclusions. Yet, the staff was clearly capable of such analysis. This logical next step in technology evaluation was not taken.

There were policy reasons why this was the case in addition to the fact that cross-comparisons would, likely, not have been welcomed by all the technology vendors. The vendors have found that participation in the SITE or ETV program have facilitated commercialization of their technologies. However, individual vendors may not find being compared by the government with other similar technologies to be beneficial. Communities, state and local regulatory officials, and consulting engineers, on the other hand, are likely to find that kind of cross-cutting analysis very helpful.

While the Committee favors the cross-cutting analyses and comparisons, it recognizes that this decision involves balancing the needs of different groups. Therefore, the Committee recommends that Agency formally re-visit this issue from time to time.

U.S. ENVIRONMENTAL PROTECTION AGENCY
Science Advisory Board
Environmental Engineering Committee (FY00)

CHAIR

Dr. Hilary I. Inyang, University Professor and Director, Center for Environmental Engineering Science and Technology (CEEST), University of Massachusetts, Lowell, MA

MEMBERS

Dr. Edgar Berkey, Vice President and Chief Science Officer, Concurrent Technologies Corporation, Pittsburgh, PA

Dr. Calvin C. Chien, Senior Environmental Fellow, E. I. DuPont Company, Wilmington, DE

Dr. Barry Dellinger, Patrick F. Taylor Chair and Professor of Chemistry, Louisiana State University, Baton Rouge, LA

Mr. Terry Foecke, President, Waste Reduction Institute, St. Paul, MN

Dr. Nina B. French, President, SKY+ Ltd., Napa, CA

Dr. Domenico Grasso, Rosemary Bradford Hewlett Professor and Chair, Picker Engineering Program, Smith College, Northampton, MA

Dr. Byung Kim, Staff Technical Specialist, Ford Motor Company, Scientific Research Laboratories, Dearborn MI

Dr. Gordon Kingsley, Assistant Professor, Georgia Tech, School of Public Policy, Atlanta, GA

Dr. John P. Maney, President, Environmental Measurement Assessment, Gloucester MA

1 **Dr. Michael J. McFarland**, Associate Professor, Utah State University, River Heights,

2 **Designated Federal Official**

3 **Kathleen W. Conway**, U.S. EPA, Science Advisory Board (1400A), 1200 Pennsylvania
4 Avenue, NW , Washington, D.C. 20460 (202) 564-4559 FAX (202) 501-0582
5 conway.kathleen@epa.gov

6 **Management Assistant**

7 **Mary L. Winston**, U.S. EPA, Science Advisory Board (1400A), 1200 Pennsylvania
8 Avenue, NW, Washington, D.C. 20460 (202) 564-4538 FAX (202) 501-0582
9 winston.mary@epa.gov

ABSTRACT

The Agency has an important role in evaluating and describing the performance of environmental technologies, especially for emerging technologies. The Environmental Engineering Committee of the Science Advisory Board recommends that the Environmental Protection Agency consider improving the information conveyed in its technology evaluation reports. The Agency should employ a broader and more comprehensive suite of measures that describe technology performance under a variety of realistic and likely circumstances.

In preparing this commentary, the Committee has used the expertise of individual members and consultants; experience gained reviewing EPA's Technology Innovation Strategy (EPA-SAB-EEC-95-013), Verification Strategies for EnTICE (EPA-SAB-EEC-016), and the Superfund Innovative Technology Evaluation (SITE) Program (EPA-SAB-EEC-97-005); presentations by EPA staff and managers of other relevant national programs; and collegial discussion.

The Committee finds that, within the limits the Agency has set for itself, EPA generally conducts technology evaluations with skill and credibility. Yet, significant improvement is still possible. Technology performance needs to be defined by all key variables, so that decision-makers are fully informed. The Agency can take several actions to assure this, including requiring use of a systematic planning process in performance testing, identifying all key variables that affect performance, determining the ruggedness of a technology with respect to these variables, and requiring that evaluation reports convey information valuable to decision-makers by having stakeholder involvement and peer reviews.

Key Words: evaluation, measures, performance, technology

NOTICE

This report has been written as a part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide balanced expert assessment of scientific matters related to problems faced by the Agency. This report has not been reviewed for approval by the Agency; and hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency or other agencies in the Federal government. Mention of trade names or commercial products does not constitute a recommendation for use.